

Article

Applications of Multi-Criteria Decision Making in Information Systems for Strategic and Operational Decisions

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Abstract: Business problems today are complicated and involve considering numerous dimensions to be weighed against each other, leading to opposing goals that must be compromised on to discover the best solution. Multi-Criteria Decision Making or MCDM plays an essential role in this situation here. MCDM techniques and procedures analyze, score, and select between options that have various conflicting criteria. This systematic review investigates applications of MCDM methods within Management Information Systems (MIS) based on evidence from 40 peer-reviewed articles selected from the Scopus database. Key methods discussed are Analytic Hierarchy Process (AHP), TOPSIS, fuzzy logic-based methods, and Analytic Network Process (ANP). These methods were applied across MIS strategic planning, re-source assignment, risk assessment, and technology selection. The review contributes further by categorizing MCDM application into thematic decision domains, evaluating methodological directions, and mapping the strengths of each method against specific MIS problems. Theoretical guidelines are suggested to align the type of decision with an appropriate MCDM strategy. The study demonstrates how the addition of MCDM enhances MIS capability with data-driven, transparent decision-making power. Implications and directions for future research are presented to guide scholars and practitioners.

Keywords: multi-criteria decision making (MCDM); information systems; Analytic Hierarchy Process (AHP); Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS); decision support systems; enterprise resource planning (ERP); customer relationship management (CRM)



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1. Introduction

The search for energy alternatives to meet present needs without compromising those of future generations is driven by the current economic climate, the rise in global energy demand, and the prudent use of available resources. Sustainable development aims to enable advancements in the research into new strategies to optimize the resources and technologies currently available. Consequently, several studies in this field have been created [1]. An information system is a cohesive group of parts that distribute cards, digital goods, and information while gathering, storing, and analyzing data. Information systems are essential for businesses and other organizations to run and oversee their daily operations, communicate with suppliers and consumers, and fight in the market [2]. Information systems have historically been utilized to support operational tasks and lower costs by automating numerous corporate processes. The function of information systems has evolved as businesses have learned to understand their significance. Information

systems are employed nowadays to lower company risks and guarantee that accurate information is available so managers may make better decisions, departing from their traditional role of supporting business operations [3].

Managerial decision making is one of the most crucial aspects of resource management, attaining both short- and long-term objectives and determining the success or failure of any endeavor [4]. Decision-makers are expected to make choices that will benefit their companies in the long run [5]. The decisions made also need to be efficient, meaningful, and infallible in addition to being effective. These choices must be logical and guarantee that the desired outcomes are obtained. The complexity of decision-making difficulties and the requirement to consider many factors mean that a decision-maker's expertise and ability need to be revised. Therefore, looking for ever-better techniques and resources is necessary to help decision making [6].

Concentrating solely on one criterion, like cutting costs, may result in less-than-ideal results and unexpected repercussions. For instance, a choice that puts cost ahead of employee happiness or product quality may have a negative impact on long-term competitiveness, staff morale, and customer satisfaction [7]. Over the past few decades, various writers have developed or refined a variety of multi-criteria decision making (MCDM) approaches, with primary distinctions about algorithmic complexity, weighting criteria methods, preference evaluation criteria representation, ambiguous data potential, and data aggregation type [8].

MCDM techniques offer a variety of potent applied mathematical techniques that enable decision-makers to select the most appropriate management approach based on their objectives and preferences. The first step in resolving an MCDM problem is establishing the weights of the attributes. The second step involves normalizing the attribute values for each management option. The third step involves aggregating the normalized attribute values into an overall index to rank the alternatives [9]. By integrating several criteria, decision-makers can get a more comprehensive and equitable viewpoint. This methodology facilitates the integration of economic, social, environmental, and other pertinent aspects, producing decisions that are more congruent with the strategic goals of the company [10].

The quality and acceptability of judgments can be improved by evaluating various criteria. Stakeholders are more likely to support the decision-making process and its consequences when they feel their concerns have been considered [11]. MCDM is a discipline created within the domains of operational research and decision engineering, and it is specifically capable of assisting in assessing alternatives based on numerous criteria [10,12–14]. Evaluating alternatives by determining the evaluation criteria, gathering stakeholder preferences, and using the preference data to create a model that compiles the multiple criteria evaluations of alternatives is known as multiple criteria decision making (MCDM). This model generates a recommendation for a decision and allows for the thorough evaluation of options [15,16].

This organized approach is very helpful in information systems, where decisions frequently involve several stakeholders and competing objectives [8]. Sensitivity analysis is made possible by MCDM approaches, which help to understand how modifications to criteria weights or alternative performance impact the final ranking or selection. For those in charge of information systems projects, this can offer insightful information [8]. Managers can use reports and data from MIS to help with planning, decision making, and operational control within a business [17]. Because numerous criterion evaluations are required to handle difficulties from multiple perspectives while managing multiple trade-offs, the application of MCDM has steadily expanded over time [18–21]. Each type of MCDM has unique advantages and disadvantages, such as the analytic hierarchy process's ease of use but interdependence problems between criteria and options and fuzzy set theory's ability

to handle inaccurate input but challenging development. At the same time, all techniques account for inconsistent and disproportionate effects of actions, compromising between objectives to prevent reaching the ideal point due to the nature of the problem [8].

Despite the extensive research on MCDM within the field of MIS, several significant gaps still need to be addressed. To the best of our knowledge, a more comprehensive review must evaluate the efficacy of different MCDM techniques across various MIS domains. This study provides a thorough synthesis of works over a wider MIS spectrum, even if other evaluations have addressed MCDM in certain MIS subfields. It presents a conceptual framework to direct researchers and practitioners, provides a comparative assessment of approaches in terms of uncertainty handling and stakeholder participation, and maps MCDM methodologies to particular MIS decision domains in a unique way. In order to close the gap between theoretical advancement and real-world MIS decision making, these contributions.

This paper follows with a literature review of the topic, and the research methodology section details the systematic review approach. The results section synthesizes key trends, patterns, and gaps identified in the literature. The discussion interprets these findings, explores implications for theory and practice, and compares different MCDM techniques. Finally, the conclusion summarizes the key findings and contributions and provides recommendations for future research.

2. Literature Review

Studies have demonstrated that MCDM is essential for assessing the efficacy of e-learning systems, emphasizing factors such as enhancements to the information system success model [22]. MCDM methods are instrumental in the decision-making process of software development in software engineering, providing frameworks for resolving intricate problems [23]. The versatility of MCDM in various domains has been demonstrated through its application in mine safety assessment through hybrid linguistic expressions and operations [24]. MCDM models have been suggested for selecting suppliers, rational order allocation, and personnel/partners in business information management, underscoring their importance in real-world decision-making scenarios [25]. MCDM research generally incorporates advancements, applications, and future directions, offering valuable insights to decision-makers and researchers in various fields [26].

Techniques for multiple criteria decision making (MCDM) have developed historically to become an important branch of operational research/management science [27]. The development of MCDM can be followed through a series of phases, represented by the Stone Age, Iron Age, Industrial Age, and New Stage, each of which stands for unique ideas, methods, and applications that allude to the main contributions of later phases [28]. The development of MCDM methods, with an emphasis on increasing accuracy, expanding application areas, and incorporating novel approaches to decision-making processes, has been greatly aided by collaboration between scientific centers in Lithuania, Germany, and Poland, especially under the direction of Professor Edmundas K. Zavadskas [29]. The literature's emphasis on MCDM's ongoing invention and development highlights the discipline's dynamic nature and applicability in tackling today's problems in various domains, including supplier selection, energy, and the environment [28].

MCDM techniques, which address the shortcomings of individual methods and propose new comprehensive evaluation approaches, include fuzzy comprehensive evaluation (FCE), grey relational analysis (GRA), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). These techniques provide thorough evaluations for choosing alternatives based on multiple criteria [30]. The use of MCDM techniques in decision-support software is still restricted despite the significance of MCDM in decision making.

The available software is divided into three categories: research-focused, experimental, and general-purpose decision support [31].

MCDM methods have been employed in various real-world applications and case studies within the field of MIS to improve the decision-making process. For example, a multinational corporation in the consumer goods industry implemented MCDM methodologies such as TOPSIS, VIKOR, and AHP to assess warehouse location alternatives, emphasizing the strategic importance of location selection in the context of supply chain performance [32]. The significance of selecting optimal maintenance strategies for industrial systems was underscored by a proposed hybrid MCDM approach that integrated FMEA, FSAW, FCM, NHL-DE, and SAW methods. This approach efficiently addressed critical failure modes while considering uncertainties [33]. Creating a multi-level fuzzy decision map (ML-FDM) method demonstrated its practicality in real-world scenarios, such as selecting wheat varieties for agricultural cultivation, by confronting the complexity of multilevel criteria and alternatives in decision-making processes [34].

Comprehensive reviews of MCDM techniques have been undertaken recently in several sectors, including business, engineering, and healthcare [26]. These studies emphasize developments, applications, and future directions in MCDM. To further improve the efficacy and applicability of MCDM techniques in actual decision-making situations, three main areas of emphasis should be addressed: integrating MCDM with emerging technologies, handling uncertainty, and taking stakeholder values into account [35]. Al-Quraishi et al. [36] applied tree-based classifiers to predict customer churn, demonstrating how objective, quantitative indicators like account balance can outperform traditional satisfaction metrics—a perspective that complements MCDM's reliance on structured, measurable criteria. It is determined that MCDM approaches can be integrated with computerized maintenance management systems (CMMS) to improve the value of gathered data and offer decision support [37]. Creating cutting-edge MCGDM models, like the m-polar fuzzy soft expert sets, demonstrates the ongoing innovation and advancement in MCDM research to handle challenging scenarios, including ambiguous information [38].

Recent research has increasingly emphasized decision making under uncertainty, machine learning integration, and adaptive modeling in MIS and related fields. For instance, Al-Quraishi et al. [39] enhanced sentiment prediction in social media engagement by combining random forest with SMOTE and SHAP, introducing a model that integrates explainability and demographic factors—an innovation that parallels the growing use of hybrid decision-support systems in MIS. Their work aligns with MCDM's broader objective of transparent and data-rich decision making. Mahdi et al. [40] provided a comprehensive roadmap on concept drift adaptation in data streams, which has implications for dynamic MIS contexts where preferences or criteria weights may evolve. Integrating such adaptive frameworks with MCDM models could increase resilience and relevance in real-time decision making. Greco et al. [18] explored methodological advances in composite indicators, especially in weighting and aggregation—core operations shared with MCDM. Their insights offer a valuable lens for refining the rigor and robustness of MCDM-based evaluations. Vlas et al. [41] examined knowledge diversification responses to uncertainty in knowledge-intensive firms. Their findings on behavioral adaptation and knowledge footprints reinforce the contextual sensitivity of decision-making frameworks, suggesting a potential synergy with MCDM tools aimed at strategic knowledge planning.

In the context of corporate sustainability (CS) research, various MCDM methods have been employed, with a preference for single MCDM methods and a recommendation to integrate three or more methods to improve decision making [42]. The necessity of conducting comparative studies under uncertain conditions to assist decision-makers in selecting appropriate MCDM methods has been emphasized, as imprecise data and

human judgment involvement are involved [43]. In the context of sustainability assessment, Cinelli et al. [44] compared five MCDA methods against ten criteria and highlighted trade-offs among them. This systematic comparison strengthens the foundation for selecting the most suitable MCDM tools for sustainable MIS applications. These contributions emphasize the importance of MCDM in MIS; however, there are still gaps in the need for additional research to integrate additional methods, resolve uncertainties, and improve decision support in various application areas, such as supplier selection and personnel/partner selection [25].

3. Materials and Methods

A systematic review is a structured, transparent, reproducible method for identifying, evaluating, and synthesizing research literature to answer a specific research question. The purpose of this systematic review is to provide a comprehensive and unbiased summary of the existing research on MCDM in MIS:

Research Questions

- I. What are the most commonly used MCDM techniques in MIS?
- II. How are these MCDM techniques applied in various MIS domains?
- III. What are the benefits and challenges associated with using MCDM in MIS?
- IV. What are the trends, gaps, and future research directions in this field?

To ensure the relevance and quality of the studies included in the review, the following inclusion and exclusion criteria were established:

The literature search was conducted across Scopus databases. The search strategy combined keywords and boolean operators to capture relevant studies:

(title-abstract-keywords (MCDM OR “multi criteria decision making” OR “multi-criteria decision making” OR “multi criteria decision-making” OR “multi-criteria decision-making”) AND title-abstract-keywords (MIS OR “Management Information System” OR “Information System Management” OR “management of information system”))

The inclusion criteria were (1) peer-reviewed journal articles or conference papers, (2) published in English, and (3) explicitly discussing the application of MCDM in the MIS context. Exclusion criteria included (1) book chapters, editorials, or non-peer-reviewed sources, (2) studies not involving MIS or MCDM, and (3) duplicate entries.

We identified 63 records through database searching. After screening, 40 papers discussing the application of MCDM techniques in MIS were included in the systematic review (Figure 1). Tools such as VOSviewer 1.6.20 were used for keyword co-occurrence mapping and thematic clustering, while Microsoft Excel was used for year-wise distribution analysis.

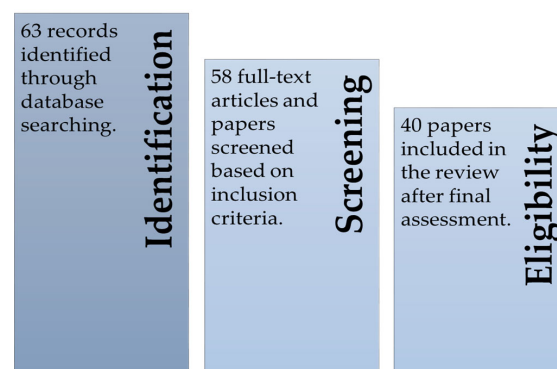


Figure 1. Process of selecting papers for review.

4. Results

The search covered publications from 1988 to 2024, with a focus on title, abstract, and keywords. Variations of key terms, including both hyphenated and non-hyphenated forms of “multi-criteria” and “decision-making”, were explicitly considered. Synonyms for MIS such as “Information System Management” were also included. A manual check ensured consistent interpretation of terminologies across selected studies.

In this systematic review, 40 articles that applied MCDM methodologies to the field of MIS were examined. Many significant trends and patterns were found during the review. Numerous patterns in the research focus on MCDM in MIS may be seen in the distribution of the 40 articles over the years. The dataset’s oldest paper is from 1988, and there was also a significant early contribution in 1991. The 2000s saw a gradual trickle of research that peaked in 2008 with nine publications, indicating a notable uptick in interest and developments in MCDM techniques in that year. Subsequently, there is a fluctuation in research activity, with some years providing three and two papers, respectively, such as 2007 and 2009. A steadier production, if not as high in volume, with one or two publications released nearly yearly, was observed in the 2010s. The number of publications in 2022 was the greatest at four, indicating a renewed focus and potential advancements in the integration of MCDM within MIS. Recent years have shown a resurgence of interest in this area. Recent contributions in 2023 and 2024, which emphasize continuous research and development in this subject, clearly demonstrate the continuation of this trend (see Figure 2).

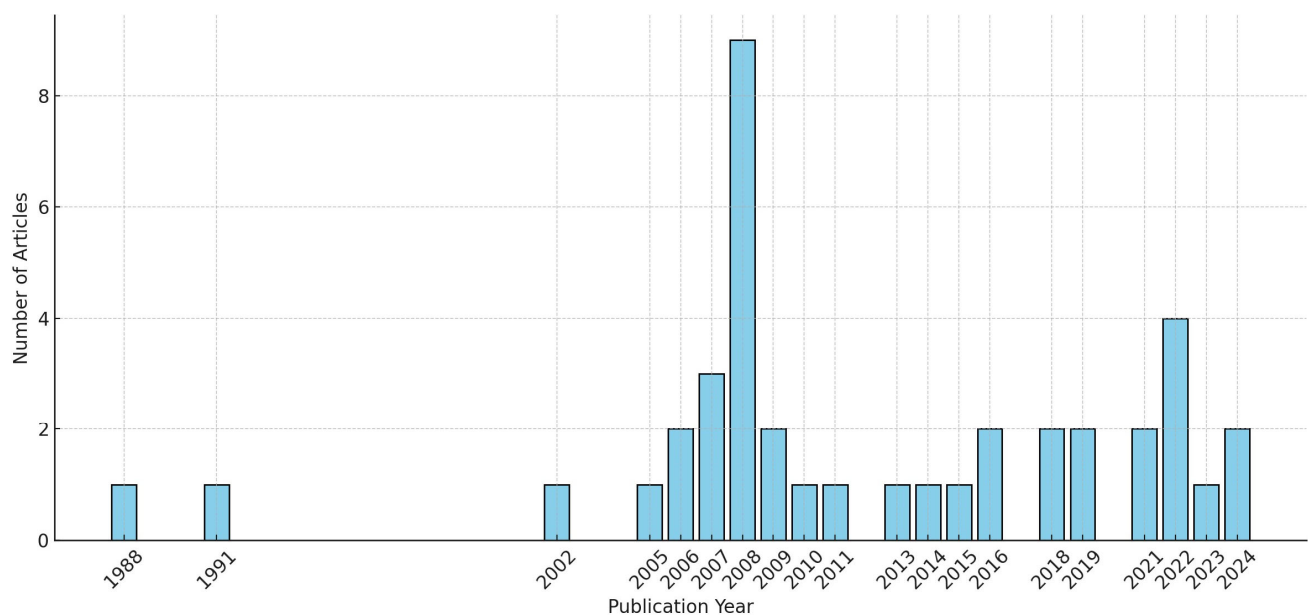


Figure 2. Year-wise distribution of MCDM-related MIS publications, based on 40 reviewed papers.

Because of their prowess in managing hierarchical structuring and ranking alternatives, AHP and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) were the most often used MCDM methodologies. For handling uncertainty, fuzzy MCDM techniques were also well-liked, and hybrid approaches—which integrate various techniques—were used to take advantage of their combined advantages. These techniques were used in the supply chain, project and portfolio management, enterprise resource planning (ERP), and customer relationship management (CRM), among other MIS fields.

The interdisciplinary engagement of the reviewed papers on MCDM in MIS is emphasized by the distribution of subject areas, as illustrated in Figure 3. The centrality of technological advancements and computational methods in the application of MCDM

within MIS is the primary focus of 25 papers, with a predominant emphasis on computer science. The relevance of MCDM in strategic decision-making and organizational management contexts is underscored by the significant contributions of business, management, accounting, and decision sciences, each of which contributed ten papers. Engineering is closely followed by 11 papers, which underscore its significance in the design and optimization of systems. The theoretical foundations and quantitative methods essential to MCDM are reflected in mathematics, which contains six papers. The social sciences, with five papers, propose an interdisciplinary approach that integrates human and organizational factors. Environmental science and materials science, each contributing three papers, emphasize particular applications in material selection and sustainability. The applicability of MCDM across various scientific domains is demonstrated by the presence of single contributions in areas such as agricultural and biological sciences, chemical engineering, earth and planetary sciences, energy, and physics and astronomy, albeit with a lower intensity than in the core.

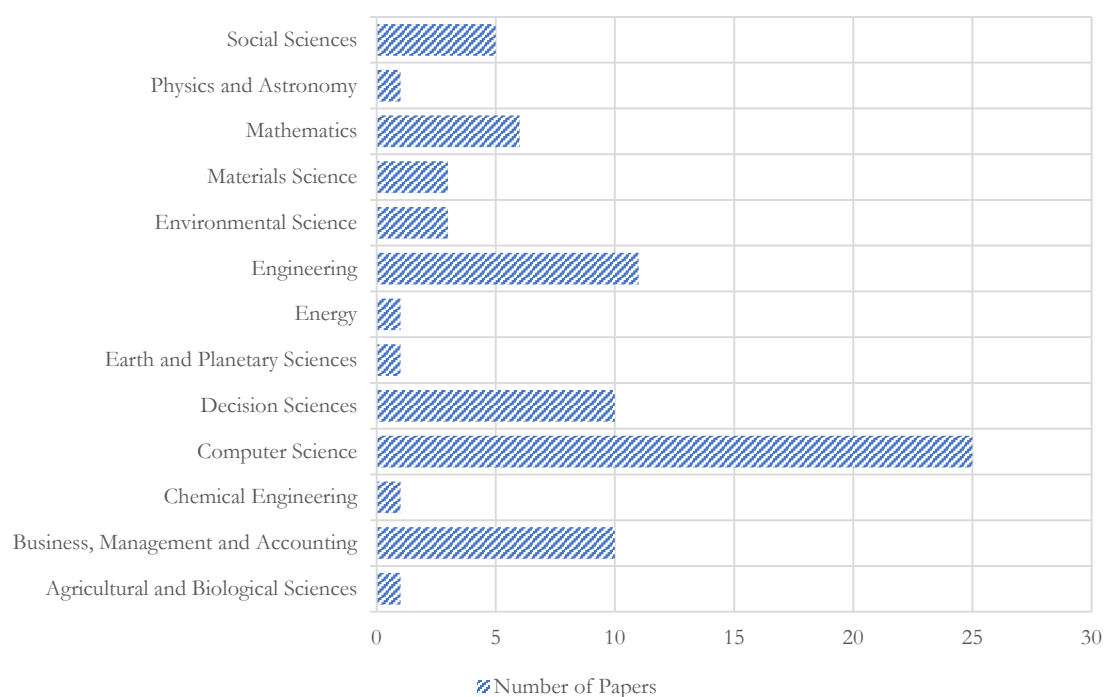


Figure 3. Distribution of subject areas.

Out of the 40 papers, the document type analysis shows a balanced distribution with 22 articles and 18 conference papers. This suggests a combination of immediate, preliminary discoveries and comprehensive, peer-reviewed studies. The increased volume of publications highlights the thorough, in-depth investigation of MCDM methodologies within MIS. Concurrently, the substantial number of conference papers emphasizes how dynamic and ever-changing the area is, allowing scholars and practitioners to share novel concepts and advancements quickly.

As illustrated in Figure 4, the core topics of “MIS” and “Decision Making” highlight the importance of enhancing decision processes in MIS. Methodologies such as “Decision Theory” and “Analytic Hierarchy Process” that are often cited point to the dependence on organized techniques.

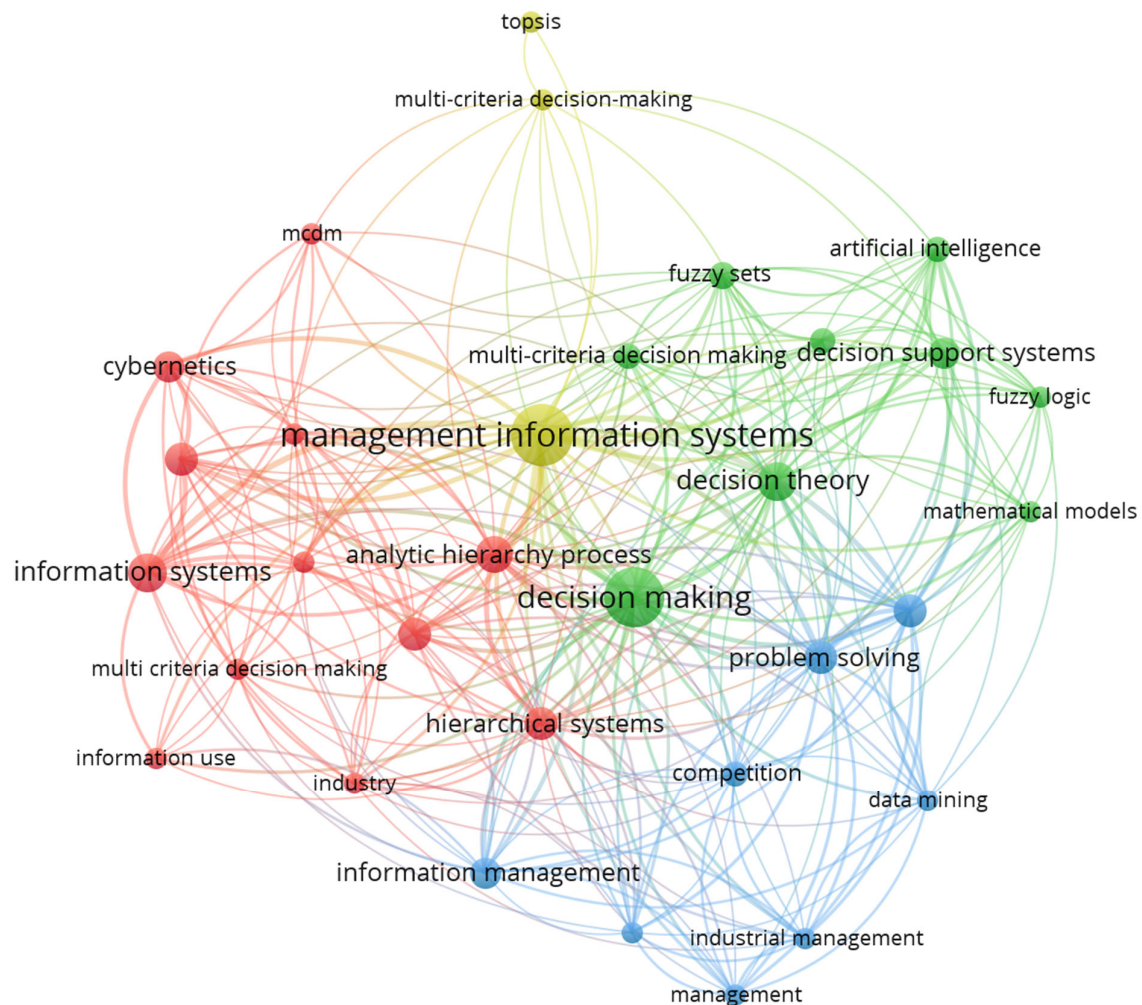


Figure 4. Keywords (both author and index) and their networks (source: VOSviewer).

5. Discussion

RQ1: What are the most commonly used MCDM techniques in MIS?

An extensive and expanding range of MCDM approaches are used in various disciplines, according to a systematic assessment of MCDM applications in MIS. The AHP is frequently used in several settings, including assessing user satisfaction with asynchronous e-learning systems [45] and choosing technology for IT projects [46]. Many MIS decision-makers favor AHP because of its versatility and user-friendliness. Mixing AHP with other methods shows how successful hybrid approaches manage complicated decision-making scenarios. One example is the study by Oztaysi [47], which combined AHP with TOPSIS-Grey for content management system selection.

The use of fuzzy logic-based MCDM techniques, which are especially helpful in handling uncertainty and imprecision in many MIS-related decisions, is another noteworthy discovery. For instance, Chen [48] used fuzzy measures to address various influencing aspects when developing a fuzzy measure and fuzzy integral-based method for IS project selection. Fuzzy logic decision making was also used in the Kavitha et al. [49] study on shop floor control to improve waste management, idle time control, and production decision-making processes. This study highlights the usefulness of fuzzy logic in enhancing operational efficiency.

The paper also emphasizes how more complex and integrated MCDM techniques are used, like the combination of DEMATEL and analytic network process (ANP). Wu [50]

suggested using a combined approach to assess and choose knowledge management solutions, highlighting the significance of considering criteria interactions. As demonstrated by earlier studies, such as Munim et al. [51], who used ANP to examine transshipment port competitiveness and highlighted Singapore’s outstanding performance and trailing green port practices, this integrated methodology offers a more thorough and realistic evaluation framework.

Variants of TOPSIS have also been shown to be useful instruments in several applications. For example, Hosseini et al. [52] employed TOPSIS to identify and prioritize obstacles to implementing MIS in higher education, offering useful information for strategic planning. Furthermore, Reddy et al.’s [53] study on the selection of high-κ dielectric materials for AlGa_N/Ga_N MIS-HEMTs shows how TOPSIS can make choosing materials easier by highlighting the top options based on various factors. These research’s consistent ranking results highlight TOPSIS’s robustness and dependability across various decision-making scenarios.

The review emphasizes how MCDM techniques might be applied in novel and developing sectors. For instance, Sakthivel Murugan and Vinodh [54] used fuzzy TOPSIS to rank design for additive manufacturing (DfAM) techniques in order of importance. This resulted in a large mass reduction and the use of finite element analysis to validate redesigns. This application shows how MCDM techniques can be easily adjusted to new technological developments and also emphasizes how they can be used to improve design processes and promote innovation. The Amazon waterlily-inspired design was the most effective in the study conducted by Ru Vern et al. [55], which incorporated AHP, TOPSIS, TRIZ, and biomimetics to design marine engine components. This work highlights the multidisciplinary potential of MCDM methodologies in engineering and design.

RQ2: How are these MCDM techniques applied in various MIS domains?

Based on a systematic assessment of MCDM studies, the implications for MIS theory and practice highlight numerous important findings and suggest future research topics. Six MCDM methodologies are graphically aligned with important MIS decision domains in Figure 5, demonstrating each method’s applicability for particular decision-making settings like performance evaluation, resource allocation, and strategy planning.

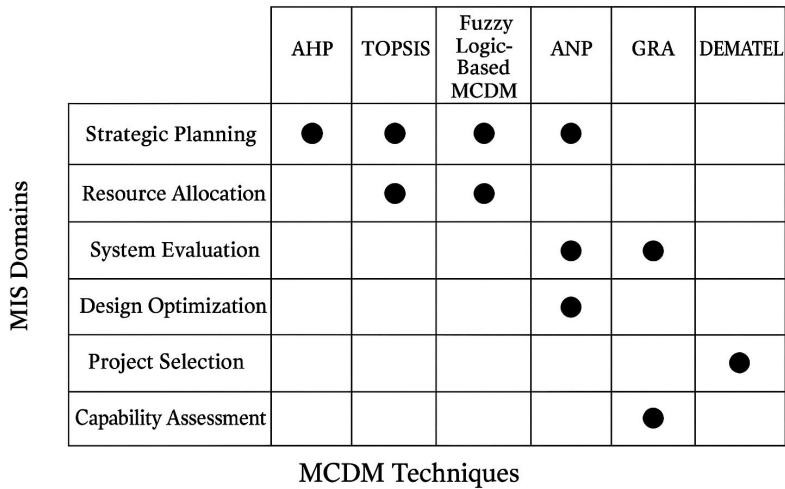


Figure 5. Mapping MCDM Methods to MIS decision domains.

a. Integration of Multiple Criteria Decision-Making Techniques

The significance of incorporating a variety of MCDM techniques into MIS frameworks to address a wide range of decision-making challenges is emphasized in the review. The

practical advantages of these methods in enhancing decision quality and transparency are underscored by studies such as those conducted by Shee and Wang [45] on e-learning system evaluation using AHP and Liu et al. [46] on technology selection with FAHP. This integration improves decision-making processes and offers a structured approach to managing the complexity and uncertainty that are endemic in MIS contexts [45,46].

b. Handling Uncertainty and Complexity

Fuzzy logic-based MCDM techniques emphasize the significance of resolving uncertainty and imprecision in MIS decision making, as demonstrated in studies like Chen [48] on IS project selection and Kavitha et al. [49] on shop floor control. These techniques enhance the dependability and efficacy of judgments made in dynamic and unpredictable contexts because they provide a strong foundation for modeling and analyzing uncertain information [48,49].

c. Enhancing Strategic Decision Making

Wu [50] and Munim et al. [51] have both demonstrated the use of advanced MCDM techniques, such as ANP and DEMATEL, in selecting knowledge management strategies and assessing port competitiveness, respectively. This suggests a transition to more strategic and comprehensive decision-making approaches in MIS. These techniques allow decision-makers to consider the interdependencies between criteria and stakeholders, promoting informed strategic planning and resource allocation [50,51].

d. Innovation and Technological Advancement

The role of these methods in driving innovation and enhancing technological advancements in MIS is illustrated by studies that apply MCDM techniques to emerging disciplines such as marine engineering design [55] and additive manufacturing [54]. MCDM optimizes processes and achieves a sustainable competitive advantage through technological innovation by prioritizing design strategies and material selections based on exhaustive criteria evaluation [54,55].

e. Practical Implementation and Adoption

The applicability and deployment of MCDM in MIS in several industries and organizational settings is one of its practical ramifications. Research such as Hosseini et al. [52] concerning impediments to the use of MIS in higher education and Reddy et al. [53] concerning material selection for semiconductor devices using TOPSIS highlights the necessity of customized methods in line with operational realities and organizational goals. This emphasizes the significance of creating scalable MCDM frameworks that are flexible and sensitive to organizational demands to close the gap between theory and reality [52,53].

RQ3: What are the benefits and challenges of using MCDM in MIS?

While MCDM techniques have been extensively used in MIS, there are significant differences regarding their suitability to specific problems (Table 1). For instance, fuzzy logic-based techniques can be most effectively utilized for handling uncertainty and imprecision and, consequently, for applications where information is incomplete or linguistic. On the contrary, AHP provides a succinct and structured hierarchy that is adequate for stakeholder engagement through pairwise comparisons but would be threatened by scalability when increasing numbers of criteria and alternatives face it. TOPSIS is computationally very straightforward and good for quantitative decision making but seems to suffer a lack of strength in subjective situations. ANP deals with interdependencies among criteria and offers more realistic modeling for complicated systems, yet it is mathematically demanding and requires an advanced level of comprehension in order to implement. DEMATEL is

unique in dealing with cause-effect relationships among criteria, complementing strategic-level choices, yet less utilized within operational MIS scenarios. This comparative view highlights the importance of context-specific selection of MCDM techniques based on data type, stakeholder interaction, and decision complexity.

Table 1. Comparative capabilities of common MCDM techniques in MIS.

MCDM Technique	Handling Uncertainty	Scalability	Stakeholder Involvement	Strengths	Limitations
AHP	Low	Moderate	High (via pairwise comparisons)	Easy to apply; transparent	Subjective bias; hard to scale
TOPSIS	Low	High	Moderate	Simple calculations; good for ranking	Assumes independence of criteria
Fuzzy AHP/fuzzy TOPSIS	High	Moderate	Moderate	Manages ambiguity in human input	More complex; parameter tuning needed
ANP	Moderate	Low	Moderate	Handles interrelated criteria	Complex calculations; requires expertise
DEMATEL	Moderate	Low	Moderate	Identifies causal relationships	Less suitable for routine decisions

a. Analytic Hierarchy Process (AHP)

Because of its organized hierarchical paradigm, which simplifies complicated problems into simpler components to aid decision making, AHP is commonly utilized in MIS [45]. Pairwise comparisons allow for subjective evaluations and offer a methodical way to rank criteria and options. When making decisions involving criteria that have the potential to be hierarchically structured, like assessing system performance [56] or choosing technological solutions [46], AHP is a good fit. Its adaptability and simplicity allow it to be used in various MIS disciplines.

b. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

Alternatives are ranked by TOPSIS according to their distance from a negative ideal and their proximity to an ideal solution, resulting in a transparent classification [52]. It can address decision problems that involve conflicting criteria by considering both benefits and costs. In MIS applications with multiple conflicting objectives, such as resource allocation [57] or technology selection [53], TOPSIS is effective. It is especially beneficial when the decision criteria are quantitative and can be normalized.

c. Fuzzy Logic-based MCDM

By allowing for linguistic variables and fuzzy sets, fuzzy logic-based techniques (such as FAHP and fuzzy TOPSIS) address ambiguity and uncertainty in decision making [48,54]. They offer adaptability in obtaining subjective evaluations and in complex decision-making scenarios. These techniques are appropriate for MIS applications that require qualitative and imprecise data, like design optimization [54] or project selection [48]. They succeed where traditional approaches would find it difficult to estimate uncertainty accurately.

d. Analytic Network Process (ANP)

AHP is enhanced by ANP, which enables feedback and dependence among criteria, rendering it appropriate for decision problems involving interdependent elements [50]. It

offers a comprehensive perspective on decision contexts by addressing intricate interactions and dependencies. ANP is advantageous in MIS applications that necessitate strategic planning and a comprehensive assessment of alternatives, such as organizational performance assessment [58] or supply chain management [59]. It accommodates the dynamic nature of decision criteria and their relationships.

e. Grey Relational Analysis (GRA)

GRA is robust for data reliability since it assesses correlations between factors under partial and ambiguous information [60]. It offers a performance comparison study without requiring exact quantitative data. GRA is appropriate for MIS applications where data quality is restricted or varies, like capability assessment [61] or performance evaluation [60]. Its emphasis on relative comparisons makes it a useful addition to conventional quantitative methods.

f. Decision-Making Trial and Evaluation Laboratory (DEMATEL)

DEMATEL assists in comprehending the cause–effect relationships in decision contexts by identifying causal relationships among criteria. It offers an understanding of the structural components of decision-making problems. DEMATEL is advantageous in MIS applications that necessitate comprehension of the interrelationships among criteria, such as in formulating strategies [50] or adopting technology [62]. It facilitates the identification of critical factors and improves decision transparency.

A comparative analysis of various MCDM techniques exposes their unique characteristics and suitability for various MIS applications. Table 2 summarizes MIS MCDM studies. The MCDM method, MIS application area, and study conclusion or findings classify each study. The multi-year experiments show how MCDM may solve complicated MIS decision-making challenges.

Table 2. Overview of studies on MCDM methods and applications in MIS.

Study	MCDM Method	Application	Outcome
[63]	Pragma	Solving discrete multiple criteria choice problems	Provides ranking frequencies of feasible actions, useful for building complete and partial preorders of feasible actions.
[64]	ELECTRE I	Selection of computer-aided software engineering (CASE) tools	Demonstrates the application of MCDM for selecting CASE tools, highlighting its potential in other software engineering decisions.
[48]	Fuzzy measure and fuzzy integral	Information system (IS) project selection	Develop a new algorithm to handle IS project selection problems by considering various influence factors using fuzzy measures.
[65]	Fuzzy GDSS based on metric distance method	Selecting IS personnel	Proposes a method to rank fuzzy numbers and develops a computer-based GDSS to increase recruiting productivity and compare different ranking methods.
[45]	AHP	Asynchronous e-learning system (AELS) evaluation	AHP evaluates AELS from the user satisfaction perspective, identifying the learner interface as the most important decision criterion.
[66]	AHP	ERP training	Applies AHP to analyze usability alternatives in an environment during ERP training.
[67]	FMCDM	M&A due diligence	Applying FMCDM to evaluate candidates during M&A due diligence, incorporating qualitative and quantitative information using fuzzy set theory.

Table 2. Cont.

Study	MCDM Method	Application	Outcome
[57]	Fuzzy MCDM	Allocating R&D resources	Suggests a fuzzy MCDM approach for R&D resource allocation, considering both qualitative and quantitative criteria with different importance weights.
[60]	Grey Relational Analysis (GRA), TOPSIS	Evaluating organizational performance and capabilities	Compares GRA and TOPSIS methods, finding consistent ranking outcomes for evaluating the performance of TFT-LCD manufacturers.
[59]	ANP	Telecom service company supply chain performance measurement	Uses ANP within a balanced scorecard framework to evaluate telecom service sector performance, providing a realistic and accurate problem representation.
[58]	AHP, ELECTRE-I, PROMETHEE	Water resources management	Utilizes various MCDM methods to manage water resources in Salta province, yielding promising results with modifications.
[50]	ANP, DEMATEL	Choosing knowledge management strategies	A combined ANP and DEMATEL approach is proposed to evaluate and select knowledge management strategies, considering interactions among criteria.
[56]	AHP	Evaluation of information retrieval (IR) systems	Refines and tests an IR evaluation model using AHP, confirming the need to include process and outcome criteria in IR evaluations.
[46]	Fuzzy AHP (FAHP)	Technology selection and specification in IT projects	Presents a FAHP-based methodology for technology selection and specification in system design, integrating it with other system design activities.
[68]	FAHP	Multi-criteria inventory classification	Designs a web-based decision support system for inventory classification, validating the system through a study in a small electrical appliances company.
[69]	Choquet integral	Knowledge management tools evaluation	Identified appropriate KM tools for improving organizational effectiveness
[70]	Fuzzy inference	Software architecture style selection	Developed DSS to help software architects choose suitable architectural styles
[71]	Fuzzy multi-criteria group decision making	Nonwoven cosmetic product development evaluation	Developed FMCGDSS for evaluating nonwoven cosmetic product prototypes
[61]	Fuzzy MCDM	Port of Keelung capabilities and core competence	Evaluated key capabilities and core competence for the port of Keelung
[72]	Fuzzy MCDM, TIA, MA	Key capabilities and core competence evaluation	Identified eight key capabilities and three core competencies for the port of Keelung
[73]	Group AHP-scoring model	Project and portfolio MIS	Selected PPM information systems for a public Greek organization
[52]	TOPSIS	MIS strategies barriers in higher education	Diagnosed and ranked barriers to utilizing MIS at Ferdowsi University of Mashhad
[74]	Hybrid IFS-TOPSIS	Project and portfolio MIS	Evaluated and selected PPMIS for the Hellenic Open University
[47]	AHP integrated TOPSIS-Grey	Content management systems selection	Selected CMS for a Turkish foreign trade company using AHP and Grey-TOPSIS
[75]	Fuzzy AHP, clustering	Business customer segmentation	Segmented business customers of an OEM using hierarchical and partitional clustering
[76]	AHP-GRA	Factory data collection systems	Evaluated and benchmarked FDC systems, finding RFID as the best choice
[77]	Priority-pointing procedure (PPP)	MIS-based project in China	Applied PPP for strategic direction in Shaanxi Provincial Government's MIS-MIFD project

Table 2. Cont.

Study	MCDM Method	Application	Outcome
[53]	Ashby, VIKOR, TOPSIS	High- κ dielectric selection for AlGa _N /Ga _N MIS-HEMT	Identified La ₂ O ₃ as the best gate dielectric for AlGa _N /Ga _N MIS-HEMT
[78]	ELECTRE III	Systems obsolescence management	Developed MCDM model for obsolescence management, ensuring sustainable and green manufacturing
[79]	VIKOR-TODIM	MIS evaluation	Proposed and verified VIKOR-TODIM method for evaluating MIS in a teaching hospital
[49]	Fuzzy logic decision making	Shop floor control	Developed a model for shop floor control using fuzzy logic, which improved decision-making processes in production, waste management, and idle time control.
[80]	Analytical hierarchy process (AHP)	Landfill site selection	Identified optimal sites for a controlled landfill in Oum Azza, Morocco, minimizing environmental impact.
[81]	COPRAS, MOORA, CRITIC, TOPSIS	Material selection for spur gear	Conducted structural analysis, identified Ti6242S as the best material using COPRAS, and validated results with TOPSIS. MOORA provided conflicting results.
[82]	CRITIC, Entropy, MEREC	Objective weighting methods comparison	Compare different objective weighting methods, highlighting similarities and dissimilarities using correlation coefficients and distance measures.
[83]	SAW, COPRAS, TOPSIS	Autonomous exploration	Evaluated exploration strategies in different risk environments, found TOPSIS effective in high-risk scenarios, and confirmed that MCDM-based strategies are superior.
[62]	AHP, DEMATEL	Adoption of MIS in medical centers	Identified and ranked factors affecting MIS adoption, finding senior management support most crucial, followed by information quality, system quality, and user experience.
[51]	ANP	Transshipment port competitiveness	Assessed and forecasted the competitiveness of transshipment ports, with Singapore outperforming others but lagging in green port management practices.
[54]	Fuzzy TOPSIS	Design for additive manufacturing	Applied fuzzy TOPSIS to prioritize DfAM strategies, reducing mass by 43.84% and validating redesign through finite element analysis.
[55]	AHP, TOPSIS, TRIZ, biomimetics	Marine engine component design	Utilized TRIZ and biomimetics for ideation and AHP-TOPSIS for selection, finding the Amazon waterlily-inspired design best, reducing stress and deformation significantly.
[84]	AHP, TOPSIS	Strengthening methods for CHS K-joints	Proposed and evaluated different strengthening methods for CHS K-joints, recommending W-T, W-S, and PFG methods based on structural performance improvements.

RQ4: *What are the trends, gaps, and future research directions in this field?*

MCDM approaches can improve MIS decision making, but research and practical applications face various hurdles. Choosing decision-making model criteria is complicated. Criteria selection often involves subjective judgment and expert opinion, which can generate bias and inconsistency [65]. Ensuring criteria relevance and appropriateness in fast-changing corporate situations is crucial but difficult.

Data are crucial for MCDM criterion evaluation and alternative ranking. However, getting accurate, thorough, and relevant data takes much work. Data quality concerns include errors, incompleteness, and inconsistency, which might reduce decision reliability [48].

Data availability may be limited in developing technologies or innovative ventures, adding to the constraints.

Many MCDM methods require subjective judgments in criterion weighting and alternative evaluation, especially AHP, which uses pairwise comparisons [45]. Subjectivity and prejudice among decision-makers can impair decision consistency and validity. MCDM research and practice struggle to mitigate subjective impacts.

ANP and DEMATEL are advanced MCDM models with extensive mathematical foundations and algorithms. These models provide extensive decision assistance, but their complexity might make implementation and interpretation easier for decision-makers [50]. To encourage real-world acceptance and usefulness, models must be simplified without sacrificing analytical rigor.

MCDM implementation in organizational processes and decision-making frameworks is complicated by organizational culture, change resistance, and system alignment [57]. MCDM integration into decision support or enterprise resource planning systems involves careful planning and stakeholder participation to guarantee smooth adoption and alignment with business goals.

MCDM model effectiveness and reliability in varied contexts are difficult to validate. Due to differences in assumptions, model parameters, and decision settings, comparative research across methodologies often produces inconsistent results [53]. MCDM strategies must be evaluated and validated to be credible and applicable in many sectors and decision domains.

Dynamic business settings complicate MCDM. Flexible decision-making frameworks are needed as choice criteria and preferences change [52]. MCDM methods must adapt to changes and uncertainty to be relevant and effective in dynamic decision environments.

To overcome these problems, research is needed to improve MCDM models, data quality and availability, transparency and interpretability, and organizational process integration.

6. Practical Implications

The study reinforces the evolving view of MIS not just as a support tool but as a strategic enabler facilitated through structured decision frameworks. The review shows how MCDM methods operationalize MIS theory by integrating performance metrics, risk assessment, and user satisfaction into decision making. Practically, the findings offer guidance for decision-makers to select context-appropriate MCDM tools—supporting a move toward evidence-based decision processes in both public and private sectors.

For small businesses, the decision-making process is frequently exposed to constrained resources as well as information. MCDM processes can be used to improve these processes. For instance, a fuzzy MCDM process can be used for supplier selection in supply chains, allowing small businesses to select the suppliers on the basis of imprecise and uncertain criteria [85]. The process improves the efficiency of the decision-making process by allowing it to accommodate the uncertainties inherent in smaller businesses. Small businesses can make use of the analytic hierarchy process (AHP) that simplifies complicated decisions into easy, manageable parts. Based on AHP, small business owners can weigh their alternatives against their own requirements and constraints.

Large companies, on the other hand, tend to be presented with more complex decision-making scenarios due to their size and diversity of operations. An example is integrating MCDM with enterprise software systems, enhancing decision-making capability to a great extent. This can be achieved by utilizing a standard enterprise software system architecture that can help chief information officers (CIOs) manage the large volumes of information associated with enterprise systems, hence making informed decisions [86].

There are advanced MCDM techniques such as the analytic network process (ANP) that big companies can use to study and prioritize projects with regard to factors such as benefits, opportunities, costs, and risks (BOCR) [87]. It allows for more precise examination of interdependencies among different decision-making factors in making strategic decisions.

Various examples illustrate the effective application of MCDM methodology across various business contexts. In one such scenario, a relocation decision-making process by companies determined that larger companies apply sophisticated decision-making paradigms in contrast to smaller companies relying on bounded information [88]. This confirms the necessity for MCDM methodology adaptation in line with individual organizational needs and possibilities. An example of another application is the use of a decision support system for cloud service selection that utilizes different MCDM approaches to improve decision making for SMEs [89]. The system enables SMEs to compare cloud services in relation to their specific business needs and maximize their working efficiency.

Organizations could experience difficulties applying MCDM methods. There could be multiple conflicting criteria to deal with, which might hinder the decision process and make a consensus hard to achieve. To work effectively as an MCDM, exact and complete information is needed, which might not always be forthcoming, especially in small enterprises. Staff might refuse to change current decision-making techniques, especially where they are set in their usual ways of thinking. Implementing MCDM in MIS involves challenges such as stakeholder resistance, data inconsistencies, and tool complexity.

- To address resistance, organizations should invest in training and participatory decision-making processes.
- For data quality issues, automated data validation and preprocessing tools (e.g., ETL pipelines in ERP systems) can help.
- To tackle tool complexity, simplified interfaces—such as spreadsheet-based MCDM templates—can support adoption in small firms.

Embedding MCDM modules into existing MIS platforms (e.g., CRM or ERP systems) allows real-time decision support. These solutions can increase adoption while ensuring analytical rigor.

7. Conclusions

The review found that MIS widely uses various MCDM techniques, including AHP, TOPSIS, fuzzy logic-based approaches, ANP, and others. These methods provide formal frameworks to manage scenarios requiring various, frequently contradictory criteria in complex decision making. TOPSIS worked well for rating options according to their proximity to ideal solutions, whereas AHP was a flexible tool for hierarchical decision structure. In qualitative evaluations, fuzzy logic-based techniques improved decision resilience by addressing uncertainty and imprecision. Additionally, integrated methods such as ANP and DEMATEL shed light on the intricate relationships between different choice criteria.

Contributions to the Field of MIS

Compared to prior reviews that focused narrowly on single techniques or domains, this study offers a broader, integrative perspective on how MCDM enriches MIS functions. The addition of a conceptual framework and method-decision mapping advances both research and practice by offering a visual decision guide. This enables stakeholders to better select, justify, and implement MCDM methods tailored to their context—filling a crucial gap in the literature.

The systematic review advances MIS by demonstrating how MCDM approaches improve decision making across various fields. The practical usefulness of these strategies

in optimizing resource allocation, technology selection, strategy planning, and performance evaluation within companies is shown by the synthesis of empirical evidence. Efficiency, transparency, and alignment with organizational goals are fostered by the methodical and informed decision-making processes supported by the incorporation of MCDM into MIS frameworks. The review also points out weaknesses and difficulties, which motivates more research and development of MCDM techniques adapted to changing corporate settings.

Using MCDM methodologies, future research should concentrate on several important topics in order to progress the field of MIS:

- I. Developing standardized guidelines and best practices for applying MCDM techniques in different MIS contexts, addressing criteria selection, data quality assurance, and model validation.
- II. Exploring advanced techniques or hybrid models integrating artificial intelligence or machine learning to handle dynamic decision environments with greater accuracy and adaptability.
- III. Investigating cross-disciplinary applications of MCDM, such as in sustainability management, healthcare systems, and smart cities, to expand the scope and impact of these techniques beyond traditional business domains.
- IV. Conducting longitudinal studies to assess the long-term effectiveness and sustainability of MCDM implementations in MIS, considering evolving technology landscapes and organizational strategies.
- V. User feedback and participatory design principles are incorporated to develop user-friendly decision support systems that facilitate stakeholder engagement and decision transparency.

Despite the broad approach, this research is subject to various limitations. Review is confined to the Scopus database, although vast, possibly excluding relevant studies indexed elsewhere. Subjectivity of study choice and interpretation of keywords, although alleviated by strict criteria, potentially introduces bias. Interpretations of theory can differ according to industry context, while the generalizability of some applications of MCDM could be limited by company size or availability of data. Future research should aim to consider expanding database sources and triangulating results by industry and geography.

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